VOL. 3 NO. 3 March 1986

COMPUTER DIGEST

A NEW KIND OF MAGAZINE FOR ELECTRONICS PROFESSIONALS

ALL ABOUT PRINTERS

Everything You Always Wanted To Know...

A GERNSBACK PUBLICATION

FREQUENCY COUNTER FOR THE C-64

Using Your Light Pen As A Tachometer.

BUILD THE GRAFEX-32

Part 2 Of This Hi-Res Graphics Adapter.

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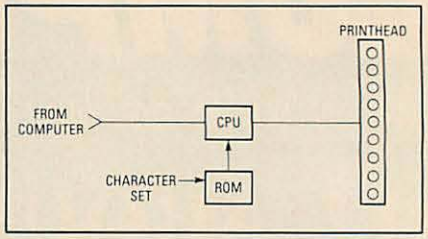

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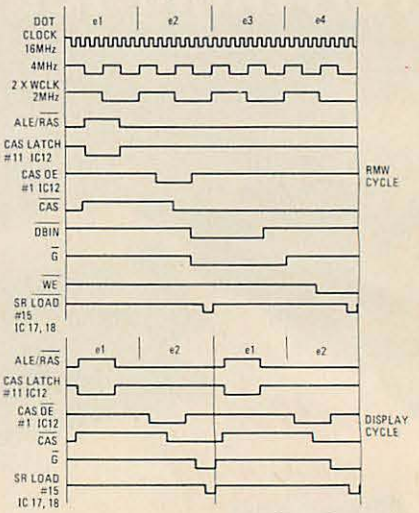

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ON THE COVER

Hold the cover of this issue to your ear. Do you hear anything? Well, maybe the new P5 Printer from NEC really isn't that quiet, but at 48 dba in the quiet mode, it's got to impress you! See page 8 for more printer info.

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COMING NEXT MONTH

What's actually required in the way of preventive maintenance for your computer? It's all spelled out in an informative article. We'll have an article on Packet Radio. And you'll find part 3, the finale, for the Grafex-32.

EDITORIAL

You've got to sacrifice...

■A friend of mine recently put his old IBM Selectric out to pasture and bought his first computer to use for word processing. He got a keyboard, a monitor, a printer and a modem along with a dual-disk drive. Now he was all set. As a professional author, he could do all his inputting on the computer, get a hard-copy printout, and shoot the copy in via modem to his publisher. His output increased, and he was very happy about the whole thing.

His wife, like so many people who aren't familiar with computers, actually resented this electro-mechanical interloper. All she knew about computers was that they were good for "playing games" and this one wasn't even used for playing games. She saw absolutely no value in the computer for herself. No value whatever.

One morning, she was on the phone with a friend who offered to give her a new and lengthy recipe. "Wait," she said, "I'll get a pencil and write it down."

Her friend, now faced with a long period of slowly reciting a dull recipe spoon-by-spoon over the phone, asked "Doesn't your husband have a computer?" She said he did, but she didn't know how to use it. The friend came over at once.

It took a quick call to my friend at his office to get the necessary password and some simple instructions, and they went into the room where the computer was, turned it on and booted up. "When the phone rings, just push this, okay?" and the friend left.

A minute later, the phone rang, the button was pressed, and the printer ran off the recipe. The last line read "Now pick up the phone." My friend's wife did so, and was told by her friend to wait, she'd be right over.

A lot of practical information was exchanged, and now my friend's wife sees the computer more as a friend than an enemy. She's got a bookful of her pet recipes stored on disk. On another disk she's got the kids' medical and school records. She keeps records of periodic car maintenance, and the computer has made her so efficient, she doesn't know how she ever got along without it until now.

A lot of the advertisers talk about their computers being "user friendly." But before anybody—or anything—can be friendly, it's got to be introduced.

Byron G. Wels

Byron G. Wels
Editor

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LETTERS

Security

I've got all of my family records on my computer and while I'm not a big corporation, I've got a feeling that my young son is "hacking" me! He seems to be able to time his requests for increases in his allowance to when I've gotten a salary increase or when I've made a large bank deposit. I don't want to shut him out of the family computer, but how do I protect personal information? S. R., Tenafly, NJ.

You are certainly entitled to your privacy. There are two things you can do. One is to protect access to this information with a password. Use 8-digit alpha-numerics and change it periodically, keeping it to yourself. The other thing is to put such information on disk and then keep the disk in one of the lockable disk holders, and keep the key with you.

Wants More.

I really enjoy the idea of a "magazine within a magazine," but I'd like more each month. Is there any way we can get more than 12 pages for ComputerDigest? —S. B., Marion, OH.

Count the pages this month, S. B. We're back up to 16, starting with this issue.

Likes Editorials

I didn't always agree with your editorials and while some were controversial, they were always fun to read. I'd like to cast my vote for their return.—M. C., Gatlinburg, TN.

Thank you sir! They were always fun to write, too. Check page 3. They're starting again with this issue as well.

Free Goodies?

I've heard that when an editor writes nice things about a product he gets one at no charge. Is that true?—L. K., Kansas City, KS

Sure. And I live in a no-charge mansion, drive a brand-new Rolls-Royce that I didn't pay for, and... Come on, I pay for my equipment just as you do! How long could an editor keep his job if he could be "bought?"

Career idea?

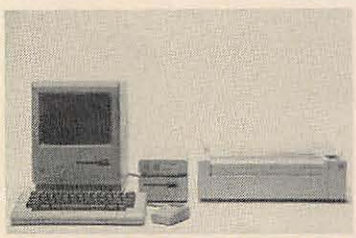
I'm in college and have to declare a major soon. Do you like what you're doing? Would you recommend it as a career? How best can I prepare for that sort of work?—J. T. Cambridge, MA.

I don't like it J. T.—I love it! If you have a bent for this kind of thing, you don't need recommendations, you're going to do it, anyway. And I'm sending you a separate, long letter with some special information, just for you!

COMPUTER PRODUCTS

For more details use the free information card inside the back cover

PRINTER BUFFER, the *MAX,* is designed for the Apple Macintosh computer. It is a 256K printer buffer, expandable up to 1 megabyte, and is connected between the Macintosh and the *Imagewriter* printer. The Macintosh users send their documents, pictures, graphics, etc. to the printer via *MAX,* which holds all the data and sends it out to the printer as it becomes free, allowing the Macintosh to go on with other jobs.



CIRCLE 11 ON FREE INFORMATION CARD

MAX features a system which, when activated, automatically pauses between pages to allow the user to insert single-sheet paper; that feature can be bypassed for continuous forms. There is also a visual indicator showing the amount of free space available. That is accomplished with a gas-tank type gauge that indicates fractional amounts of fullness. The suggested retail price of *MAX* is $749.00, Canadian, and $549.00 U.S.— **DataSpace Corporation,** 205 Riviera Drive, Unit 9, Markham, Ontario, Canada L3R2L6.

COMPUTER INTERFACE, the *Powerhouse,* is designed to enable Apple and Commodore computers to control automatically all electrical devices in a home, store, or office. It is the size of a paperback book, is supplied with software on diskette and a computer interface cable.

The software graphically displays each room in a house and tells the user how to select the lights, TV's, stereos, air conditioning and heating

CIRCLE 12 ON FREE INFORMATION CARD

systems, and any other electrical devices to be controlled. Menus depict front and rear views of the building so that outdoor lighting, or an automatic lawn sprinkler can also be programmed. The brightness of any

individual light can be set to a selected level.

The *Powerhouse* is priced at $150.—**X-10 (USA) Inc.,** 185A Legrand Avenue, Northvale, NJ 07647.

PAPER STACKER, has been designed to replace the wire baskets currently used with most computer printers. The patented center slot supports and bends the first sheet of fan-fold paper

CIRCLE 13 ON FREE INFORMATION CARD

resulting in double the stacking reliability. The stacker is injection-molded in high-impact polystyrene and has no moving parts. The *Paper Stacker* is priced at $45.95.—**U.S. Designs,** 7670 SW Barnard Drive, Beaverton, OR 97007.

ATTACHE CASE, the *Ambassador,* is designed for users of the Apple *IIC.* It features top grain genuine leather with padded rigid form and suede lining interior; specially padded compartments and cover with Velcro fasteners;

CIRCLE 14 ON FREE INFORMATION CARD

three expandable legal, oversize, and computer-printout portfolio pockets; three pen/pencil holder loops; two software storage pouches; solid brass patented lock with changeable, three-wheel combination locks; solid core leather handle, and much more. The *Ambassador* is priced at $199.00.—**TCK International Co.,** 1766 Devon Drive, Glendale Hts., IL 60139.

SOFTWARE PACKAGE, *The Little Black Book,* is a software package that takes names, adresses, phone numbers, etc., and puts them together, then prints them out quickly in little black book size. It can take 400 entries, in 30 different categories, at your creation. Each individual entry can have a cou-

CIRCLE 15 ON FREE INFORMATION CARD

ple of lines of notes. And should you lose any printout sheets, they can easily and quickly be replaced, because the data is safely stored on diskette. *The Little Black Book* is priced at $49.95.—**Cygnet Technologies, Inc.,** 1296 Lawrence Station Road, Sunnyvale, CA 94089.

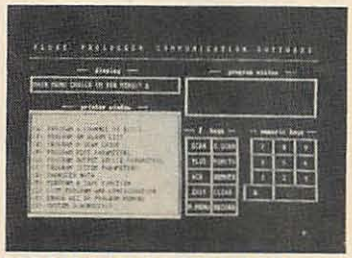
EDUCATIONAL GAME, *Beach-Head,* is designed for Apple computers and work-alikes. *Beach-Head* is an action/strategy game that features high-resolution graphics, sound effects, and multiple scrolling playscreens. Gameplay is initiated either through a joystick or the keyboard, and the program accommodates one or two players. A demonstration mode allows practice on individual phases of the game, and a provision for recording high scores to disk is also included.

CIRCLE 16 ON FREE INFORMATION CARD

Using a war scenario, *Beach-Head* leads the player through various phases that include torpedo-infested waters, a full-scale air assault, a sea battle, and a land invasion through an obstacle-laden stretch of beach. After successfully completing those phases, the player is faced with the final and ultimate conflict at the fortress of Khun Lin. The player must eliminate the ten gun-turrets of the citadel with his tanks before the enemy's mortar destroys him. When all ten of the ramparts have been neutralized, the enemy waves a white flag of surrender.

Beach-Head comes on disk, and has a suggested retail price of $34.95.—**Access Software, Inc.,** 2561 South 1560 West, Woods Cross, UT 84087.

SOFTWARE PACKAGE, the *ProLogger,* links an IBM *PC, XT,* or *AT* with the Fluke *2280* series Advanced Data Loggers. *ProLogger* software turns the IBM *PC* into a high-accuracy data-acquisition system, simplifying control and report generation.



CIRCLE 17 ON FREE INFORMATION CARD

The package enables the Fluke *2280* series data loggers to be operated from an IBM *PC.* The operator can create and edit application programs on the IBM *PC* and download them to either the Fluke *2280B* or *2285B.* The data logger then handles all A/D conversions, linearizations, and control functions, freeing the *PC* for other tasks. Programs can be developed in BASIC, or by responding to the friendly, menu-driven prompts of the Fluke *2280* series. To help simplify programming, the PC's screen displays a likeness of the *2280* front-panel display during program development.

ProLogger software facilitates report generation, by automatically retrieving data and storing it in a report format of the author's choice. The new package allows an IBM *PC* to retrieve data from a *2280* series data logger, and store it in a LOTUS 1-2-3 format. The *ProLogger* is priced at $295.00; the package includes a diskette and manual.—**John Fluke Mfg. Co., Inc.,** PO Box C9090, Everett, WA 98206.

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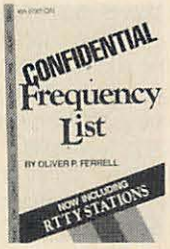

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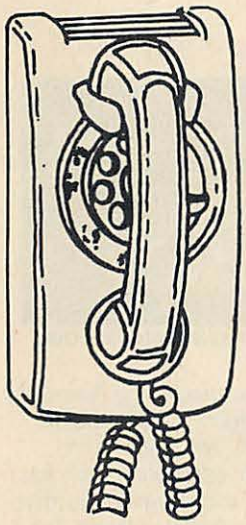

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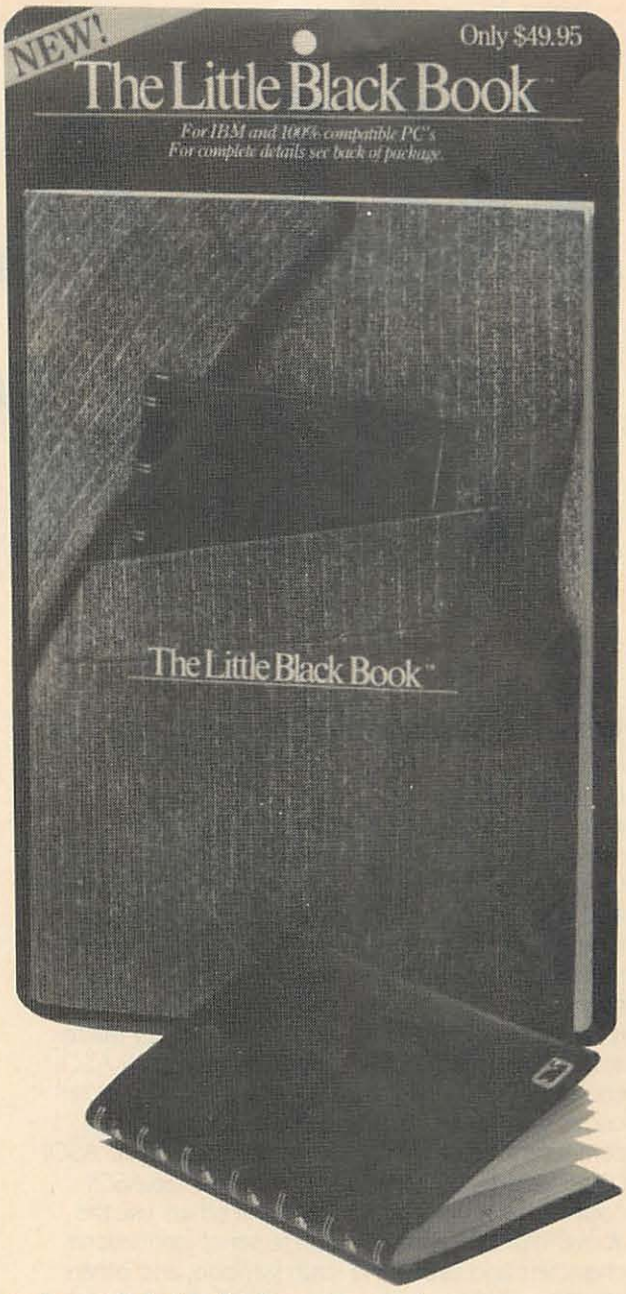
Soft cover; 308 pages of practical, proven plans for the electronics hobbyist...circuits, converters, amplifiers, synthesizers, optoelectronics, power supplies and more. Written and designed by Forrest M. Mims, III. **$11.50** plus $1 postage in USA. **ELECTRONIC TECHNOLOGY TODAY INC., PO Box 240, Massapequa Park, NY 11762-0240.**

SOFTWARE REVIEW

The Little Black Book.


NEW!
Only $49.95
The Little Black Book
For IBM and 100% compatible PC's
For complete details see back of package
The Little Black Book

■Actually, there would really be no need for this product... No need at all. Provided that you could as easily slip your entire computer into your breast pocket. But short of that, you're going to find The Little Black Book from Cygnet Technologies (1296 Lawrence Station Road, Sunnyvale, CA 94089 (800) 621-4292) the handiest peripheral you've bought for your computer since you decided to add a monitor!

This is an idea whose time has come.

Chances are that one of the first things you thought to do was put your telephone directory into your computer. Now you can run a printout of that directory on ordinary computer printout paper, cut on the dotted lines, and staple the info into this 400-entry directory which fits in a shirt pocket. Lose it, and all you need to do is print out a new one. Each of the entries offers name, address, phone number and notes; you can define up to 30 entry categories and you can use multiple entries for cross-referencing. Let's see you do *that* with your ordinary address book!

You say you aren't satisfied? You say you want more for your money? Tell you what we're gonna do. In addition to printing out your personal telephone directory, the software will—get this—automatically dial telephone numbers including access codes to your own long-distance dialing system! The optional dialer board is available at an additional cost of $70.

Let's be practical. An executive on-the-go will certainly need one of these, but when you hear about some of the applications to which they're being put, you wonder how business ever got along without them. Take the New York based sales manager with a staff of far-flung salesmen all over the country. He simply bought additional book covers, one for each salesman, and has his secretary update the regional leads that come in each month. These are sent to the men in the field who add them to their own books.

The system, complete with a nicely packaged book cover, the software, all you need, works with IBM's and compatibles, Lotus 1, 2 and 3, Symphony, and most PC/DOS programs. It's yours for only $50. That's right, I said fifty bucks.

Uniform

For the most part, the oft-occurring changeover from CP/M to MS-DOS machines is a smooth one. One reason for that is the fact that most of the popular software for the older format is also available for the IBM and its compatibles. In fact, the data files created by the CP/M versions of word processors, spreadsheets, datas bases and the like are almost always compatible with the MS-DOS versions of that software. But, the disk formats are not.

In the past, the process of transferring your CP/M-software generated data files to MS-DOS disks has been a tedious and primitive one. Now, thanks to a new piece of software, that job is as simple as inserting your CP/M disk into your IBM's drive.

That new software, called Uniform, enables your MS-DOS machine to directly read and write disks from almost any of the popular CP/M formats, and to initialize a blank disk in the CP/M format of your choice. That means data files created by a CP/M machine can be used directly by an MS-DOS machine and vice-versa.

The software is easy to use; menus, prompts and easy-to-understand messages guide you through. Once invoked to select a disk format, you simply use the MS-DOS commands (COPY, etc.) and software with which you are familiar. Also, no modification of your hardware is needed.

For more information, contact Micro Solutions, Inc. 125 S. Fourth Street, DeKalb, IL 60115. ◀●▶

ALL ABOUT PRINTERS

What you see may NOT be what you print!

Herb Friedman

■With few exceptions printers rarely are 100% compatible with any modern personal computer. Even when the printer has the same marque as the computer it's a good bet it won't print all the characters and symbols shown on the screen. Manufacturers often upgrade or modify the characteristics of their latest models to accommodate the features of the most recent software or hardware fad. While every printer must print the ASCII characters represented by ASCII codes 32 through 126—those we call "the character codes"—outside this range anything goes. Some computers create block graphics in response to ASCII codes above 126, others use the above-126 ASCII codes for a separate Italics font, still others use the above-126 codes for a complete set of international characters and Greek and math symbols, and others use the codes for partial international character sets.

Then there are the ASCII codes below 32—what are called "the printer control codes." While the line feed (LF), carriage return (CR) and back space (BS) are virtually standard, the remaining codes are used for whatever the manufacturer selects: Some use them for conventional printer controls, others employ some of the under-32 codes for graphic symbols such as the four playing card suits, the international male and female symbols and musical notes; anything at all.

Few printer buyers realize that "What they see ain't what they print" until it's too late. For example, two of the most famous, best-selling printers cannot reproduce the graphics and characters above ASCII 126 produced by the IBM and IBM-compatible personal computers, although one printer can be retrofitted to provide some of the upper-ASCII characters. In the home-and family category, no known non-proprietary printer can reproduce all the graphics of the Commodore 64, and any conventional printer used with the Apple II familly of computers must use shifted graphics because the conventional Apple printer interface has a seven-bit printer output, which limits the ASCII codes to 126.

In order to get around inherent printer limitations and be able to reproduce any character or symbol, some of the very latest printer designs—such as certain models from Epson and Panasonic—provide a user RAM area in which the user can store user-created or custom-designed characters.

Characters in ROM

All matrix printers are controlled by a microprocessor. As shown in Figure 1, a simplified functional diagram of a matrix printer, the microprocessor receives either serial or parallel data from the computer which it compares with a character set stored in ROM. For each conventional ASCII code there is a matching character or control function stored in ROM. (The codes for which no ROM character is provided are generally ignored by the printer.) The microprocessor also controls the movement of the print

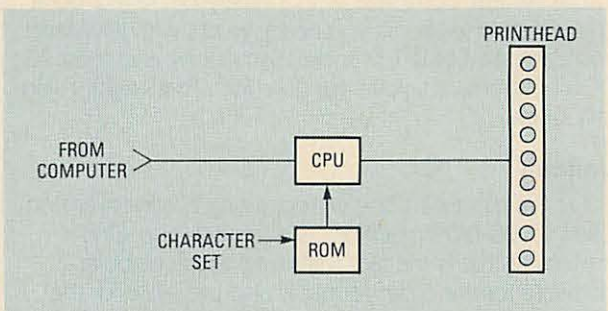


FIG. 1—THE BASIC MATRIX PRINTER drives the print head using a character set that is entirely within ROM. There is no way to modify the inherent characters or substitute user created characters.

head and the firing order of the print head wires that imprint the dots from which the characters are formed. The print head of most modern low cost printers employ 9 wires, of which up to 7 are used to create the characters (all 9 might be used for graphics). The extra wires are needed in order to create the descenders for lowercase characters such as the "p" "g" and "q." Figure 2 shows how the printer's CPU shifts from the seven upper to the seven lower wires in order to create upper and lower case characters in the Epson FX+ printer. Each character is created in a matrix 9 dots high and 6 dots wide. The dots represent the actual firing of the wires as the head is moved from left to right across the paper. If the head had only 7 wires the lowercase characters would be shifted upwards and lack descenders, as they did in the earliest of personal computer printers. Also note from Figure 2 that in some instances the dots are printed not in a column but on the "line(s)" between the column: It is possible to print a total of nine dots in a matrix only six dots wide. The very last column is not normally used for characters because it provides the spacing between characters.

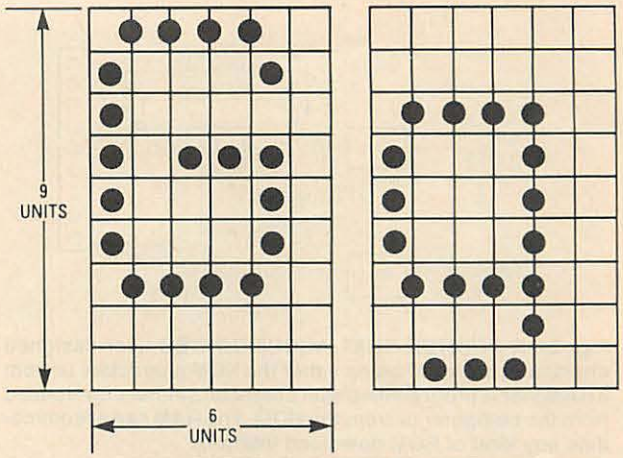


FIG. 2—THE CONVENTIONAL MATRIX PRINTER employs a 9-wire head even though only 7 wires are used for each character. The two "extra" wires are needed for lower case descenders, such as the "tail" shown on the lower case "g." Notice that the dots can be printed in a column or between columns. The extreme right hand column is left free for conventional characters because it provides the space between adjacent characters.

The required ASCII code, head movement and the firing sequence of the wires for each character are programmed into the ROM along with the printer functions and cannot be changed. The printer will print only the character for which it is programmed even if the computer uses the same ASCII code for a different character, symbol or graphic. For example, if a particular printer has the same Italic character set as the Epson FX+ printer only the Italic characters will be generted by printer codes higher than 161. If the computer outputs an ASCII 234, which is the printer's lowercase Italic "j," the printer will print the "j" even though the same ASCII 234 code is recognized by the computer as the omega symbol. As far as the computer is concerned it is outputting the Omega symbol displayed on the screen, but as far as the printer is concerned the computer is sending an Italic "j."

But because a matrix printer's characters are created by individual dots it's possible to custom design any kind of character, symbol or graphic, even a complete character set from ASCII 00 to ASCII 256. All that's required is some way to supercede the ROM-based character set. This is accomplished, as shown in Figure 3, by driving the print head from a RAM buffer—user-programmable memory—rather than from the ROM. When the print is made the characters will be those of the programmable RAM rather than those of the ROM.

Ram permits the user to create a custom design for any or all ASCII codes, or to store one or more characters from the ROM character set and customize only specific ASCII codes. The CPU can either drive the matrix printhead from the ROM character set, or it can drive the print head from the RAM buffer. The ROM/RAM switching, the programming of RAM with custom characters, and the selection of ROM characters to be emulated in RAM are under software control, and can be entered either as direct statements, or as part of a BASIC program, or in certain select instances as a printer control code (the RAM/ROM switching) from within an applications program.

Let's illustrate printer programming using the ASCII 234 code previously discussed. If we wanted to substitute the Omega character for the Italic "j" we could program the entire ROM-based character set except for ASCII 234 to load into the RAM and then load a user-generated ASCII 234 representative of Omega (Ω) from the computer using a short BASIC program. As long as power to the printer wasn't interrupted it would print an Omega in response to an ASCII 234. Or, we could program the entire ROM character set from ASCII 00 through 126 into ROM, and then program only the custom designed ASCII 234. The printer would ignore all ASCII codes higher then 126 except for ASCII 234.

The user-designed characters must fit within what is called the "matrix" of the printer, which is simply a box representing all the dot positions that can be used to create a character. In the Epson FX+ printer the matrix is 9 x 11, meaning 9 vertical dots by 11 horizontal dots, as shown in Figure 4. Confused? No, there is no error in Figure 4. As we explained earlier in Figure 2, the dot matrix is 9 x 6, but dots can be printed between the columns; in effect, the matrix is 9 x 11. (Also as mentioned earlier, as a general rule the extreme right column is never used for the character because it is the minimum space needed between characters, but there is nothing to prevent the user from employing the column for special graphic effects or double-width characters.)

For example, Figure 5 shows how RAM programming can be used to create a customized font (type face) or individual characters. The FX+ printer is factory supplied with the Roman character set: The straight-sided characters we recongnize as "computer printing." Figure 5A shows how the Roman "E" is generated: Notice the dots are located precisely within the matrix boxes. Let's assume that the user prefers to

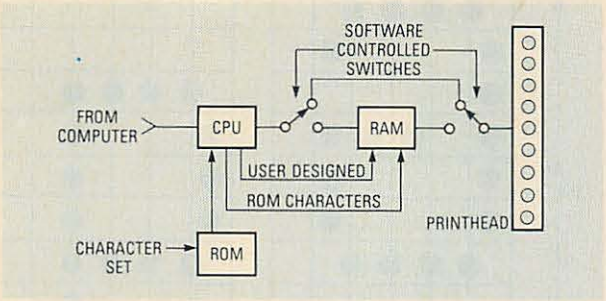


Fig. 3—A PRINTER THAT ACCOMODATES user-designed characters can print using either the ROM characters or from a RAM that is programmed with characters either downloaded from the computer or from the ROM. The RAM can accommodate any kind of ROM/download intermix.

have the printing more closely resemble the characters of a conventional typewriter, what is called NLQ, meaning "near letter quality." The distinction between the characters is serifs or rounded corners, and the user could custom design and program the printer with a substitute character set resembling conventional pica characters, such as the letter "E" shown in Figure 5B. If the user wanted to modify only the shape of the letters but not the numerals or punctuation symbols he could load the new upper and lower case letters into RAM along with the numerals and punctuation form the ROM roman character set. With the printer's CPU programmed to operate from RAM the printout would contain NLQ letters and Roman numerals and punctuation. A complete NLQ character set for letters, numerals and punctuation could be designed and loaded into RAM. It is even possible, as shown in Fig 5C, to program a graphic symbol such as the Omega.

Generally, we try to use whatever we can of the ROM characters. Designing a custom character set is not a one-evening project. The characters are created by a BASIC program: An individual character requires an attribute statement that positions the character in the 9 x 6 matrix, and a data line for each row. The data lines

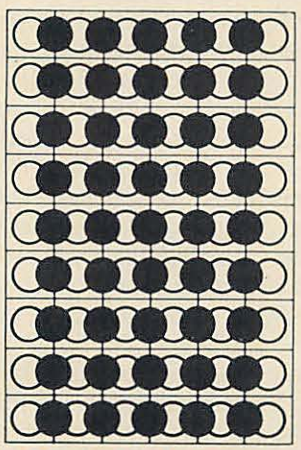


FIG. 4—CUSTOM-DESIGNED CHARACTERS are formed from a 9 x 6 matrix which actually provides 11 columns of dots. The characters are created by firing any of the indicated dots, however adjacent white and dark dots cannot be used; the printer will ignore an indicated dark dot if the immediate adjacent dot is white.

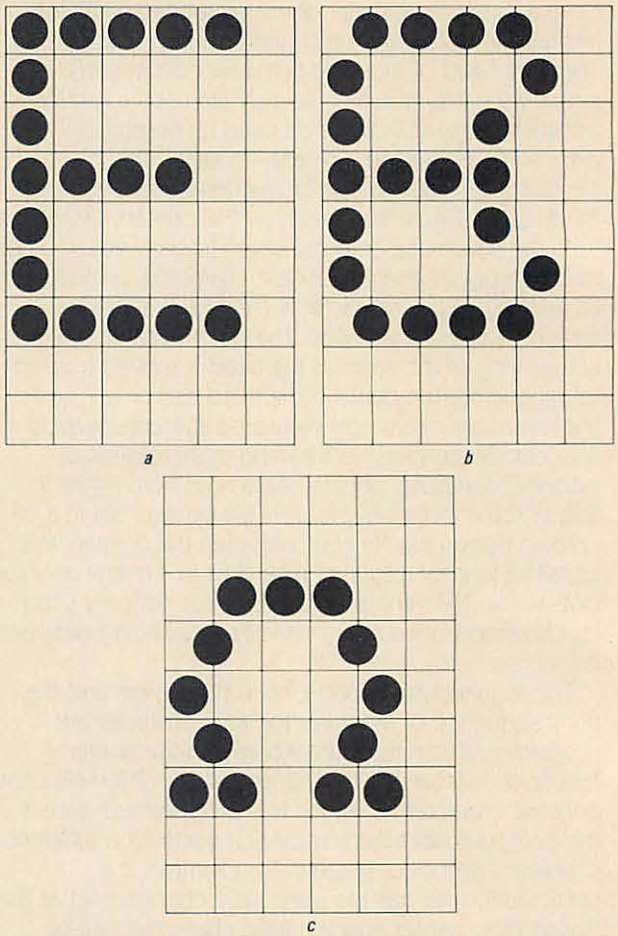


FIG. 5A—THE CONVENTIONAL ROMAN CHARACTER has straight sides and looks "computerized." This is how a dot matrix printer creates the Roman "E."

FIG. 5B—THE 'NLQ"TYPE CHARACTER—which resembles typewriter characters—can be created by the user and downloaded into RAM as a substitute for the Roman characters. This is how a user-created NLQ "pica" character might be created. Although full NLQ printing is attained by multistriking in such a way that the spaces between the dots are literally filled in, the basic character is created from individual dots.

FIG. 5C—SINCE THE CUSTOMIZED CHARACTERS are created from dots almost anything is possible. This is the pattern for Omega, the symbol we use to indicate resistance.

represent the byte value for each column of dots, and since there are nine possible columns for each character it would take considerable time and debugging tocustom design no more than a handful of characters. It is probably less time and trouble to purchase a program that automatically downloads an NLQ or IBM-compatible character set(s).

While there is software available for some commonly-used non-programmable matrix printers that generates custom character sets through the printer's dot addressable function, the printing process itself tends to be s-l-o-w because each letter might require several passes of the print head. On the other hand, printers having custom characters programmed into RAM have no loss in throughput because the printer doesn't know whether it's printing ROM-based internal or RAM-based custom characters.◀Ω▶

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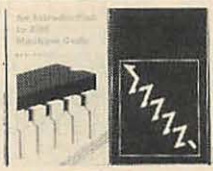

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FREQUENCY COUNTER FOR YOUR C-64

A new use for your light pen.

Ralph Neal

■After building the light pen described in the June, 1985 edition of **ComputerDigest**, I began thinking of possible uses for it. One idea, was as an optical tachometer for measuring the speed of rotating objects such as fans or motors. The program presented here is the result. Using this program and a light pen compatible with the Commodore C-64, you can measure the rotational speed of most objects.

The program was originally written in Assembly Language and later converted to data statements to make the program easier to type into the computer. Unfortunately, there is one drawback to this. Without the source code, it is difficult to see how the program functions. However, we'll explain.

How the program works

If it were not for the fact that computers are very-fast adding machines, this system would only work at low frequencies. We take advantage of the computer's speed by having it count the number of times the light pen is activated per second. At the point where the second has ended, the program stops counting and displays the count to the screen for about two seconds. After this, all values are zeroed and the count begins again as sensed by the light pen.

Obviously, timing is everything if this system is to function properly. And all of the timing is accomplished by use of the Jiffy Clock, which is an interrupt-driven clock. The computer keeps a continuous count of the number of times interrupts occur and stores this count at memory locations 160 - 162. However, of these three memory locations, we are concerned only with location 162. This location is updated every 1/60th of a second. All we have to do to check to see if a second has passed, is compare this location with the number 60. When memory location 162 reaches 60, the program stops counting and jumps to a time-out subroutine. This subroutine continuously checks the same memory location (location 160) for a value of zero. This value will *only* be obtained after the count in memory location 162 has passed 255. Once the value in location 162 is equal to zero, the program jumps to the start and is again ready to record events detected by the light pen.

```
5 REM* OPTICAL TACHOMETER *
10 PRINT"□"
20 POKE 53281,1
30 FOR I=32768 TO 32971
40 READ X
50 POKE I,X
60 NEXT I
70 SYS32768
80 DATA169,1,141,255,3,173
90 DATA24,208,9,2,141,24
100 DATA208,32,172,128,169,48
110 DATA141,255,4,141,0,5
120 DATA141,1,5,141,2,5
130 DATA141,3,5,169,72,141
140 DATA5,5,169,26,141,6
150 DATA5,169,0,133,162,162
160 DATA4,24,164,162,192,59
170 DATA176,109,32,150,128,189
180 DATA255,4,109,255,3,157
190 DATA255,4,201,58,208,234
200 DATA233,10,157,255,4,202
210 DATA189,255,4,105,0,157
220 DATA255,4,201,58,208,213
230 DATA233,10,157,255,4,202
240 DATA189,255,4,105,0,157
250 DATA255,4,201,58,208,195
260 DATA233,10,157,255,4,202
270 DATA189,255,4,105,0,157
280 DATA255,4,201,58,208,177
290 DATA233,10,157,255,4,202
300 DATA189,255,4,105,0,157
310 DATA255,4,201,58,208,159
320 DATA233,10,157,255,4,202
330 DATA173,0,220,41,16,208
340 DATA249,173,0,220,41,16
350 DATA240,249,96,165,162,208
360 DATA252,76,16,128,162,0
370 DATA189,186,128,157,50,4
380 DATA232,224,17,208,245,96
390 DATA70,82,69,81,85,69
400 DATA78,67,89,32,67,79
410 DATA85,78,84,69,82,96

READY.
```

First connect the light pen to joystick port 2. Then turn on the computer and load the program listed. When run, the program should clear the screen and turn the background of the monitor to white. A simple test to check out the program, is to place the light pen against the screen of the monitor. A value of 60 should appear on the screen if the program is functioning properly. (The value may fluctuate between 59 and 61 on some monitors.)

There are some limitations to this program. From tests conducted, it would appear that the limiting readable frequencies are about 10,000Hz. At this frequency, the optical tachometer reads about 9650Hz, some 450Hz from true value.◀◘▶

BUILD THE GRAFEX-32 PART 2

RAY DAHLBY

This article, begun in February is continued here.

A 7220 display cycle requires 2-2Xwclk cycles and a RMW cycle requires 4-2Xwc1k cycles. The sequence of events which takes place during a RMW cycle is outlined below. The four 2Xwc1k intervals are referred to as e1, e2, e3, and e4 as per the timing diagram, Figure 3.

The intervals description follows:

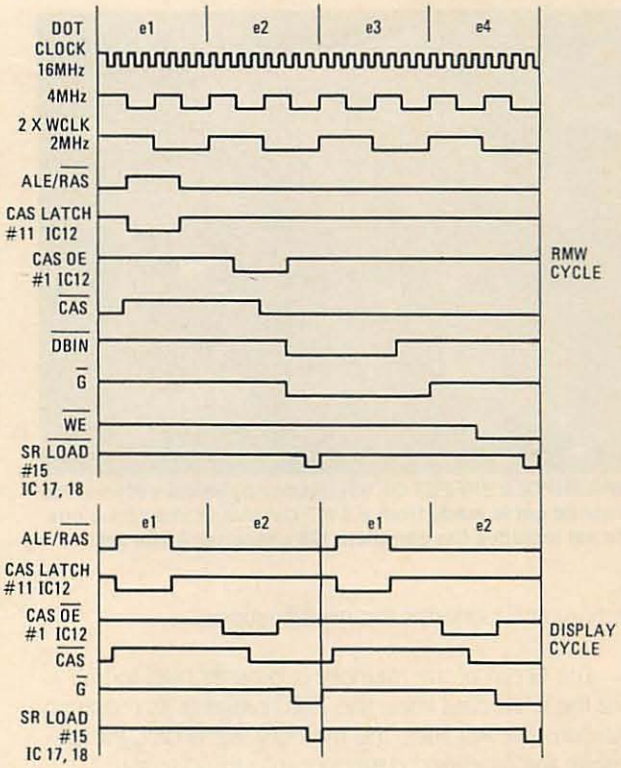


FIG. 3—TIMING DIAGRAM illustrates timing steps and sequences. See text for further information.

e1—The 7220 begins to output the display memory address on the 16 AD lines; ALE goes low to indicate this address is valid. This signal (also called RAS) strobes the low 8 address bits into the display memory and latches the high 8 address bits into the CAS latch, IC12.

e2—The 7220 tri-states the AD lines and DBIN goes low to indicate that a RMW cycle is in progress. The CAS latch OE pin is brought low to present the 8 column address bits to the display memory and then, the CAS line is brought low to strobe this address into the display RAM chips. The G pin of the memory is brought low to allow the read data to be presented to the 7220. The read data is loaded into the video shift registers.

e3—The 7220 reads the 16 bit data from the display

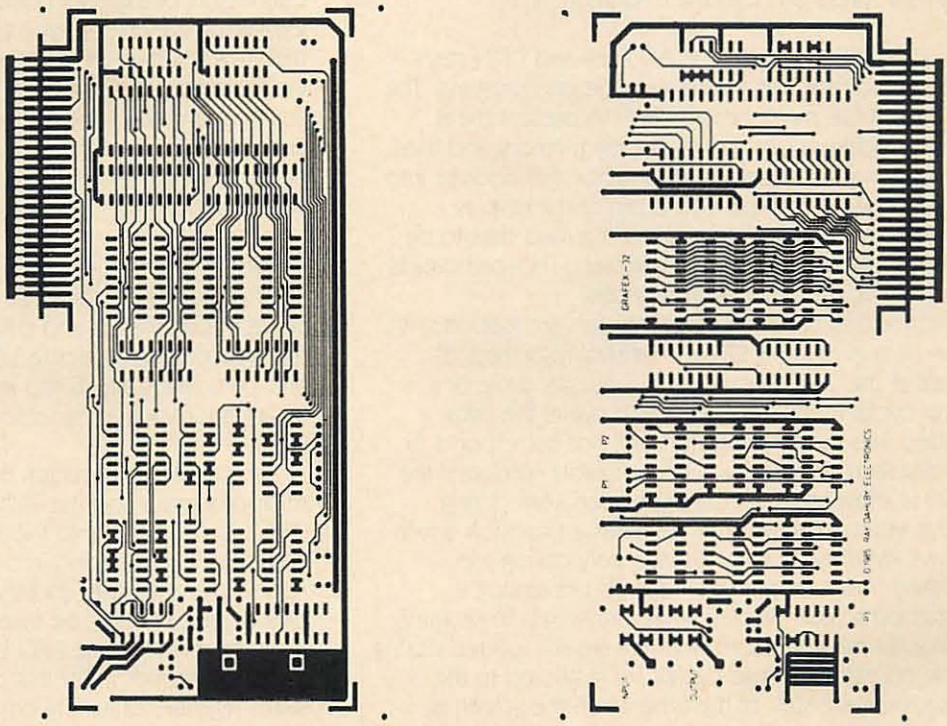
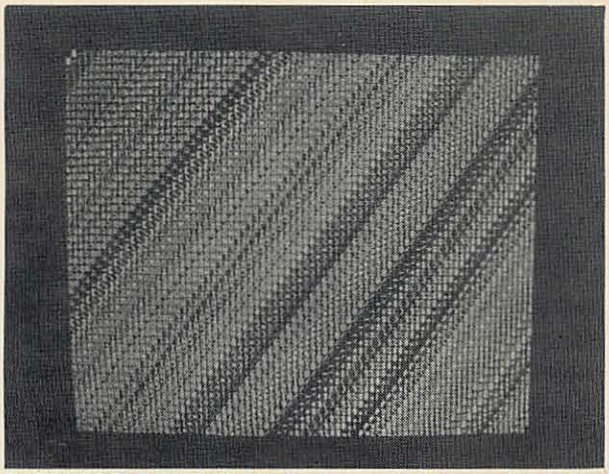
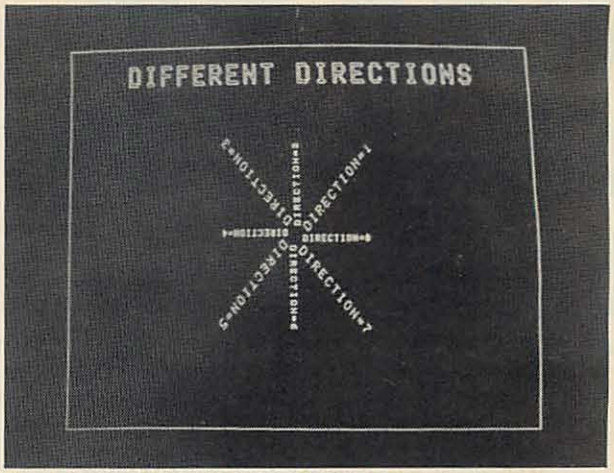


FIG. 4—PRINTED CIRCUIT BOARD is shown half size for those who wish to make their own. Due to space restrictions, board had to be reduced 50%. Be sure to have these drawings photographically enlarged 200% before making board. Component side is shown at left.



BARBERPOLE EFFECT OF 80 columns by 50 rows of text. The character set is made from a 5 x 7 dot matrix in an 8 x 8 box. This set includes the complete 128 character ASCII set.



THE EIGHT DRAWING DIRECTIONS. The display was produced by writing the string "DIFFERENT DIRECTIONS" at a magnification factor of 2, then writing it again with the x and y starting position shifted by 1 pixel and the mode set to complement.

memory and performs the modifications.

e4—The G pin of the memory is brought high to tri-state the RAM data lines, the 7220 presents its modified data onto the AD lines, the memory WE is brought low to write the modified data back into the display memory. The modified data is loaded into the video shift registers.

The two 2Xwc1k intervals which make up a display cycle are outlined below. Again, e1 and e2 refer to the 2Xwc1k intervals labelled on the timing diagram.

e1—The 7220 begins to output the display memory address on the 16 AD lines; ALE goes low to indicate this address is valid. This signal strobes the low 8 address bits into the display memory and latches the high 8 address bits into the CAS latch, IC12.

e2—The 7220 tri-states the AD lines and DBIN stays high to indicate that a display cycle is in progress. The CAS latch OE pin is brought low to present the 8 column address bits to the display memory and then, the CAS line is brought low to strobe this address into the display RAM chips. The G pin of the display memory is brought low to allow the read data to be presented to the video shift registers. The read data is loaded into the video shift registers.

Notice that the video shift registers are loaded with new data every two 2Xwc1k interval regardless of whether the 7220 is executing a display cycle or a RMW cycle. In the case of a RMW cycle, the data loaded into the shift registers will not correspond to valid screen data and will cause visible glitches if the 7220 is allowed to access the screen RAM during active video intervals. The 7220 has a provision which allows RMW cycle to take place only during the blanked Vsync and Hsync intervals preventing a disturbed screen display while drawing is in progress. Although the video shift registers are still loaded during RMW operations, these cycles are restricted to the approximately 30% of the time when the screen is blanked, preventing the false data from being seen.

When two or more boards are installed in a system, they are daisy-chained together by means of the expansion connectors, P1 and P2. These connectors carry the 16 MHZ dot clock and the 7220 video sync signals from the board designated to be the master, to the slave boards. The jumper on P3 is installed only on the board acting as the master. When initiallized by software, the slave 7220's synchronize their timing with the master so that all of the 7220's run in phase with each other. In this way, three Grafex boards installed in a system can each drive one gun of an RGB color monitor. The composite sync is carried on the video for those monitors capable of accepting sync on the green input. RGB monitors having external synchronization inputs can be driven from one of the expansion connectors of a Grafex board. Specific information explaining the use of three Grafex boards with RGB monitors is included with the color software package available from my company. Please check with the source mentioned at the end of this article for price and delivery information. Figures 4 and 5 provide necessary information should you prefer to fabricate your own boards.

Programming the 7220

After power up, the 7220 must be initiallized by a series of commands and parameters to configure it for the type of display desired. Usually, these commands and parameters are stored in a table which the initialization routine can refer to and then pass to the 7220.

The path for information flow between the host microprocessor and the 7220 is the first-in first-out (FIFO) buffer internal to the 7220. Commands and parameters and loaded into this buffer by the host and removed at the other end by the GDC's command processor. Care must be taken by the programmer to avoid overflowing the FIFO buffer with data faster than the GDC empties it. For this purpose, the GDC has a status register containing bits which indicate when the FIFO buffer is full or empty and also when data is ready

TABLE 1

Address	Read	Write	Video Relay
CONO	Status Register	Parameter	Apple Video Displayed
CON1	FIFO	Command	
CON2	Status Register	Parameter	Grafex Video Displayed
CON3	FIFO	Command	

to be read by the host microprocessor. Referring to Table 1, the status register can be seen to be mapped into the Apple's expansion slot area and can be read at any time. Other bits in this register indicate the state of the Vsync and Hsync video timing counters to allow smooth scrolling and other effects needing software synchronization to the video field rate.

The first command issued after power up is the Reset command. This command is interpreted by special hardware ahead of the FIFO to ensure that the internal registers, FIFO buffer, and command processor of the GDC are reset to their idle state prior to the initialization commands and parameters which follow. Normally, it is a good idea to check the status register for a FIFO FULL condition before each byte is output. On power up, the flags in the status register are not meaningful, so the RESET command must be issued before attempting to read the status register or load other commands and parameters into the GDC.

A typical initialization program is shown in Listing 1.

Listing I

```
:L
 1 IO        EQU  $FE
 2           ORG  $0300
 3           LDA  #$F2        ;SLOT7
 4           STA  IO
 5           LDA  #$C0
 6           STA  IO+1
 7 INIT      LDX  #00
 8 LOOP      LDA  TABLE1,X
 9           LDY  TABLE2,X
10           STA  (IO),Y
11           INX
12           CPX  #30
13           BNE  LOOP
14           RTS
15 TABLE1    DFB  $00,$1F,$26,$04,$1A
   ,$0B,$1E,$CB,$40,$6F,$47,$28,$70,
   $00,$00,$00,$19,$4B,$00,$C0,$00,$
   46,$00,$7B,$FF,$FF,$23,$4C,$10,$6
   B
16 TABLE2    DFB  1,0,0,0,0,0,0,0,0,1
   ,1,0,1,0,0,0,0,1,0,0,0,1,0,1,0,0,
   1,1,0,1
```

GRAFEX-32 Power and Ground Pin-outs

	+5volts	ground
IC1	40	20
IC2	14	7
IC3	14	7
IC4	14	7
IC5	14	7
IC6	14	7
IC7	14	7
IC8	14	7
IC9	14	7
IC10	16	8
IC11	20	10
IC12	20	10
IC13	9	18
IC14	9	18
IC15	9	18
IC16	9	18
IC17	16	8
IC18	16	8
IC19	16	8
IC20	16	8

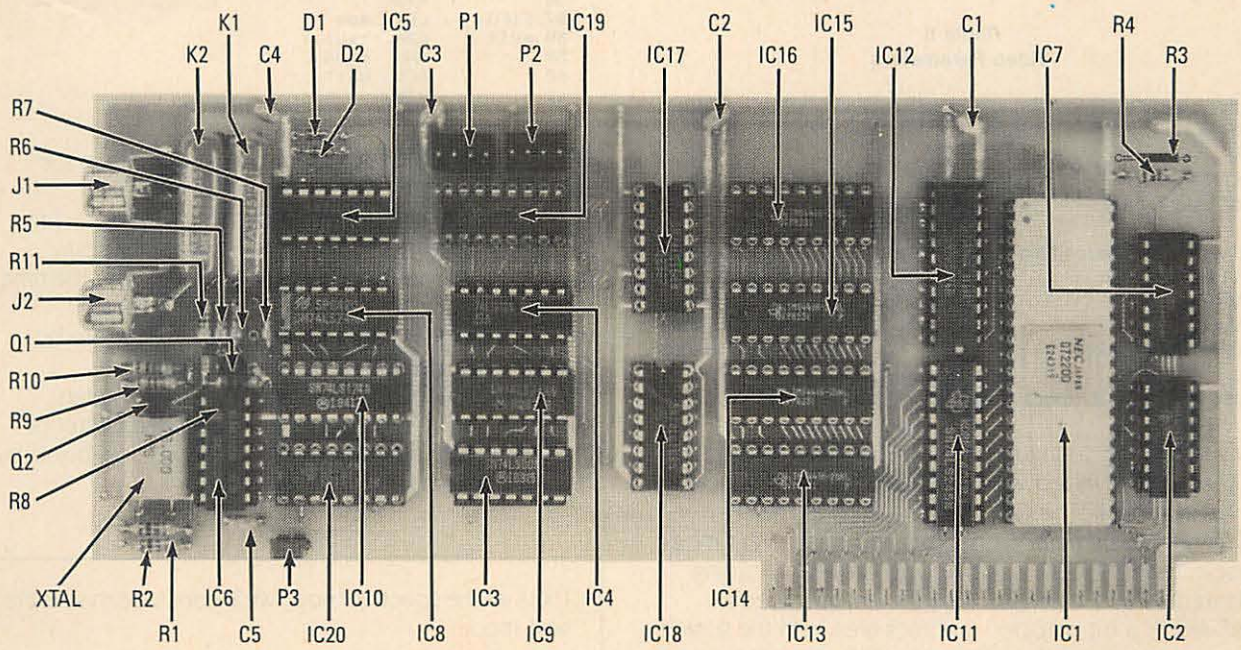


FIG. 5—PARTS PLACEMENT is shown above. No components are mounted on reverse side of board.

:L

Listing II

```
 1 IO       EQU  $FE
 2          ORG  $0300
 3          LDA  #$F2       ;SLOT7
 4          STA  IO
 5          LDA  #$C0
 6          STA  IO+1
 7          JSR  FIFO       ;MAKE SURE FIFO IS EMPTY
 8          LDY  #01
 9          LDA  #$49       ;CURSOR COMMAND
10          STA  (IO),Y
11          DEY
12          LDA  #00
13          STA  (IO),Y
14          STA  (IO),Y
15          INY
16          LDA  #$4A       ;MASK COMMAND
17          STA  (IO),Y
18          DEY
19          LDA  #$FF
20          STA  (IO),Y
21          STA  (IO),Y
22          INY
23          LDA  #$0F       ;SYNC COMMAND
24          STA  (IO),Y
25          DEY
26          LDA  #$0F       ;FAST MODE
27          STA  (IO),Y
28          LDX  #$00
29 LOOP     LDY  #01
30          LDA  #$4C       ;FIGS COMMAND
31          STA  (IO),Y
32          DEY
33          LDA  #$02
34          STA  (IO),Y
35          LDA  #$FF
36          STA  (IO),Y
37          LDA  #$3F
38          STA  (IO),Y
39          INY
40          LDA  #$22       ;WDAT MODE
41          STA  (IO),Y
42          DEY
43          LDA  #$FF
44          STA  (IO),Y
45          STA  (IO),Y
46          JSR  FIFO       ;MAKE SURE FIFO IS EMPTY
47          INX
48          CPX  #$01       ;CHANGE TO #$04 FOR 128K
49          BNE  LOOP
50          RTS
51 FIFO     LDY  #00
52 WAIT     LDA  (IO),Y
53          AND  #$04
54          BEQ  WAIT
55          RTS
```

Table II
Video Parameters

Active Line =	40μs
HFP =	7μs
HBP =	12μs
HSYNC =	6μs
Total Line Time	64μs

Active lines per video field =	200 lines
VFP =	30 lines
VBP =	16 lines
Vsync =	16 lines
Total lines per field =	262 lines

Video field rate = 1/64μs × 262 lines) = 59.637 Hz

This sequence configures the GDC to generate 640 by 400 interlaced video with the video timing parameters given in Table II. The GDC is designated as master, dynamic RAM refresh is enabled, and transparent mode is selected (the GDC is allowed to draw only during blanked screen intervals). Also the entire screen is defined as a bit-mapped graphics area with the screen window set to the top of memory. When this program is run, the 7220 begins outputting video to the system

:L

Listing III

```
 1 IO       EQU  $FE
 2          ORG  $300
 3          LDA  #$F2       ;SLOT7
 4          STA  IO
 5          LDA  #$C0
 6          STA  IO+1
 7          JSR  FIFO       ;MAKE SURE FIFO IS EMPTY
 8          LDY  #01
 9          LDA  #$23       ;WDAT MODE
10          STA  (IO),Y
11          LDA  #$78       ;PATTERN RAM
12          STA  (IO),Y
13          DEY
14          LDA  #$FF
15          STA  (IO),Y
16          STA  (IO),Y
17          INY
18          LDA  #$49       ;CURSOR COMMAND
19          STA  (IO),Y
20          DEY
21          LDA  #$81
22          STA  (IO),Y
23          LDA  #$17
24          STA  (IO),Y
25          LDA  #$00
26          STA  (IO),Y
27          INY
28          LDA  #$4C       ;FIGS COMMAND
29          STA  (IO),Y
30          DEY
31          LDA  #$40
32          STA  (IO),Y
33          LDA  #$03
34          STA  (IO),Y
35          LDA  #$00
36          STA  (IO),Y
37          LDA  #$63
38          STA  (IO),Y
39          LDA  #$00
40          STA  (IO),Y
41          LDA  #$63
42          STA  (IO),Y
43          LDA  #$00
44          STA  (IO),Y
45          LDA  #$FF
46          STA  (IO),Y
47          LDA  #$3F
48          STA  (IO),Y
49          LDA  #$63
50          STA  (IO),Y
51          LDA  #$00
52          STA  (IO),Y
53          INY
54          LDA  #$6C       ;FIGD COMMAND
55          STA  (IO),Y
56          RTS
57 FIFO     LDY  #00
58 WAIT     LDA  (IO),Y
59          AND  #$04
60          BEQ  WAIT
61          RTS
```

CRT monitor from the random power-up data in the display memory.

A screen clear sequence is shown in Listing 2. This sequence clears the entire 32,768 bytes of display memory to zeroes in under 16 ms, or less than the time required for one video field. This routine can be modified to clear 128K bytes of display memory by changing the indicated line to: CPX #$04.

A final sequence of commands and parameters, shown in Listing 3, draws a rectangle in the center of the screen with the dimensions of 100 vertical pixels by 100 horizontal pixels.

That's all the space for now. We'll conclude this article next month.